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No. 57

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USSR REPORT

PHYSICS AND MATHEMATICS

No. 57

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PHYSICS

ISOLATION OF SOUND FIELDS GENERATED BY VARIOUS SOURCES BY MEANS OF PLATE-
SURFACE IRREGULARITIES IN A PLATE

LAPIN, A. D., Acoustics Institute, USSR Academy of Sciences

[Abstract] This is a continuation of a previous study (Lapin, A. D., AKUST,
ZH., 24, 6, 893-898, 1978) which dealt with calculations of the isolation of
plane longitudinal and flexural waves in a thin plate by small periodic
irregularities at the plate's surfaces. Now the problem of the isolation of
acoustic fields generated by various types of sources in a plate with uneven
surfaces is examined. The problem is solved for the following sources: a
radially pulsating disk (monopole), a rotationally oscillating "frozen-in"
rigid disk, and the source of a force oriented normal to the plate. In a
thin plate of constant depth these sources generate longitudinal, shear, and
flexural cylindrical waves, respectively. Formulas for plate-surface
irregularities effectively reflecting these waves are derived, and the sound
isolation they provide in the plate is calculated for each case considered,
thus providing a picture of the acoustic fields of the different sources in
a plate with small surface irregularities, with allowance for multiple scat-
tering of sound. References: 4 Russian.
[165-1386]

TRANSVERSE ACOUSTOELECTRIC EFFECT IN INHOMOGENEOUS SEMICONDUCTOR STRUCTURES

GULYAYEV, YU. V., MOROZOV, A. I. and POLZIKOVA, N. I., Moscow, Institute of
Radio Engineering and Electronics, USSR Academy of Sciences

[Abstract] It is shown that the transverse acoustoelectric (AE) effect
can arise in inhomogeneous semiconductor structures in the presence of a
uniform acoustic wave energy over their cross sectional area and in the
absence of the capture of electrons by surface traps. This only requires
that the specimen itself be inhomogeneous over its cross sectional area--
e.g. that it contain a non-uniform electron concentration distribution or
a non-uniform electron mobility distribution over its cross-sectional area.
This is so because sound absorption varies over the cross section of the

specimen, since the sound absorption factor is a function of the local concentration or mobility of electrons, and hence the intensity of the longitudinal acoustoelectric current caused by the entrainment of electrons by the acoustic wave will differ over the cross section of the specimen. This, in its turn, results in the appearance of a difference in potentials between points within the specimen in the transverse direction, i.e. it will result in the transverse AE effect in question. Equations describing the distributions of currents and fields in the specimen are presented, and the equation of the field potential is derived, along with approximate values of the transverse AE effect. It is shown that the non-uniform entrainment of electrons by the acoustic wave in a transversely inhomogeneous specimen results in the formation of a circular electrical current. References 6: 5 Russian, 1 Western.
[182-1386]

A NEW FUNCTIONAL CONFIGURATION FOR THREE-MICRON CRYSTAL LAYERS

KAMINSKIY, A. A., USSR Academy of Sciences Institute of Crystallography
imeni A. V. Shubnikov, Moscow, and PETROSYAN, A. G., Armenian Academy of
Sciences Physics Research Institute, Ashtarak-2, presented by Academician
B. K. Vaynshteyn, 22 Jan 79

[Abstract]   Previous improvements in the power performance of three-micron
erbium crystal lasers utilized schemes which speeded up the "flowing" of
the residual excitation (after a lasing event) from the $^4I_{13/2}$ state to
the levels of deactivator ions specially introduced into the crystal (Tm^{3+}
or Tm^{3+} and Ho^{3+}), as well as a scheme with "extra feed" excitation of the
initial lasing state $^4I_{11/2}$ from the levels of sensitizer ions (Yb^{3+} or
Yb^{3+} and Cr^{3+}). A new scheme is proposed in which the conditions for stim-
ulated radiation are improved through the simultaneous use of sensitization
processes (Yb^{3+} to Er^{3+} or Yb^{3+} + Cr^{3+} to Er^{3+}) and deactivation processes
(Er^{3+} to Tm^{3+}). This combination scheme is termed feedflowing. Laser ele-
ments 40 mm long and 5 mm in diameter with plane-parallel faces were fab-
ricated from the following specially grown crystals having sensitizing and
deactivating ions permitting a reduction in the excitation threshold for
the 26,990 Å line: $Lu_3Al_5O_{12}$:Yb^{3+} (5 at.%), Tu^{3+} (3 at.%)- Er^{3+} ($\simeq$ 33 at.%)
and $Lu_3Al_5O_{12}$:Yb^{3+} (5 at.%), Tm^{3+} (3 at.%), Cr ($\simeq$ 0.3 at.%)- Er^{3+} ($\simeq$ 33
at.%). All of the crystals were grown along the [100] crystallographic
axis. The values of the excitation threshold energies ranged from about
5.5 to 18 Joules; these figures indicate the promise of this crystal for
applied purposes, and research indicates that these figures are not optimal
ones. A further improvement is possible by means of choosing the optimum
composition of the coactivator ions and their concentration, working temper-
ature and excitation pulse width. Similar results in improving the excita-
tion conditions for the stimulated radiation for Er^{3+} ions at the lines of
the self-saturating transitions $^4I_{11/2}$ to $^4I_{13/2}$ were also obtained for a
series of coactivated $Y_3Al_5O_{12}$ crystals. Figures 1; references 13:
11 Russian, 2 Western.
[178-8225]

ELECTRON RADIATION IN PLANE CHANNELING

BAYER, V. N., KATKOV, V. M., STRAKHOVENKO, V. M., Novosibirsk, Institute of Nuclear Physics, Siberian Affiliate of the USSR Academy of Sciences

[Abstract]   Since the motion of electrons in a channel formed by crystalline planes (plane channeling) is quasiperiodic (as opposed to periodic in a system in which the electron is generally at rest), it should be accompanied by characteristic electromagnetic radiation. Prior research into such radiation has been based on certain model assumptions as to the form of the potential, and the resulting estimates have not been in agreement with experiment. In this connection, now the potential is taken in a form sufficiently close to the real, and the radiation characteristics that can be directly measured in experiment are derived. The mathematical description is confined to the classical description of the movement of electrons in a channel as a function of interplanar potential. A formula for that potential, taken in a form not significantly different from the potential based on the Thomas-Fermi model, is derived. The formula can be used to determine all the characteristics of the radiation, such as the period-averaged radiation intensity as a function of the entrance angle and the spectral intensity distribution. Figures 3; references 7: 5 Russian, 2 Western.
[180-1386]

VARIBAND AND BARRIER PHOTOELECTROMOTIVE FORCE OF A VARIBAND p-n STRUCTURE

BERKELIYEV, A., VOLKOV, A. S., IMENDOV, A. N., LIPKO, A. L., NAZAROV, N., SULEYMENOV, B. S., TSARENKOV, B. V. and YAKOVLEV, YU. P., Leningrad, Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract]   Variband photo-emf, when combined with barrier photo-emf, can be utilized in the p-n structure to enhance the efficiency of solar photovoltaic cells. In this connection, the barrier and variband emf in a $n\text{-}GaAs\text{-}p\text{-}p^{+}\text{-}Ga_{1-x}Al_xAs$ structure were investigated. It was found that the width of the forbidden band E_g in $p\text{-}Ga_{1-x}Al_xAs$ monotonically increased

from 1.43 to 1.92 eV in the direction from n-GaAs with a gradient of $_\nabla E_g$ = 1-1.5 keV/cm. The concentration of equilibrium electrons in n-GaAs was $3 \cdot 10^{17}$ cm^{-3} in all structures; the variband p-layers were doped so that the principal part of the layer was uniformly doped with acceptors and the concentration of equilibrium holes $p_p \simeq 2 \cdot 10^{14} - 5 \cdot 10^{17}$ cm^{-3} in the various structures, while the subsurface p$^+$-layer in all the structures was heavily doped to $p_p \simeq 5 \cdot 10^{18}$ cm^{-3}. A photo-emf representing the combination of barrier emf with volumetric emf consisting of variband photo-emf and the photo-emf of the p$^+$-p junction was experimentally obtained. That combined photo-emf was found to: 1) increase with increase in photon energy within the range corresponding to the width of the forbidden band of the variband semiconductor; 2) increase in the presence of high luminous flux densities at a rate that was the faster the lower the equilibrium hole concentration in the variband semiconductor; 3) decrease in two stages following the cessation of photoexcitation--first, rapidly, owing to the disappearance of the volumetric photo-emf, and then slowly with decrease in the barrier photo-emf; 4) exceed the forbidden-band width in the p-n junction region at temperatures below 200 K. At a temperature of 77 K and in the presence of high luminous current densities ($6 \cdot 10^{21}$ phot./cm^2·sec) variband photo-emf accounts for the principal part of the volumetric photo-emf, amounting to 0.26 V. The maximum combined photo-emf attained amounted to 1.72 V at 77 K and 1.38 V at 293 K. Given a thousandfold concentrated density of the solar flux, when the solar photovoltaic cell still can operate in the continuous mode under forced cooling, the photo-emf of n-GaAs-p-p$^+$-Ga$_{1-x}$Al$_x$As structures could be augmented by 25% by adding the volumetric photo-emf to the barrier photo-emf: this makes promising the utilization of volumetric photo-emf in solar photovoltaic cells. Figures 6; references 4: 3 Russian, 1 Western.
[181-1386]

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SPECIAL FEATURES OF THE ELECTROPHYSICAL PROPERTIES OF THALLIUM-DOPED PbS

KAYDANOV, V. I., MEL'NIK, R. B. and NEMOV, S. A., Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] Thallium is known to affect markedly the electrophysical properties and solubility of excess components in lead selenide. Previously, however, the behavior of kinetic coefficients and the solubility of excess

components in PbS $\langle Tl \rangle$ has not been investigated. In this connection the Hall (R) and Seebeck (α) coefficients were investigated within the 77-450 K temperature range on polycrystalline specimens obtained by a powder metallurgy method. The specimens were homogenized at T = 750°C for 100 hr in quartz vacuum ampoules. All specimens of the $Pb_{1-x}Tl_xS$ composition displayed p-type conductivity. The hole concentration p_{77} was derived from the Hall coefficient measured at 77 K in a magnetic field of 2 T. Plots of the concentration dependence of the thermo-emf coefficient (α) and the R_T/R_{77} ratio in PbS $\langle Tl \rangle$ and PbS $\langle Na \rangle$ showed that doping with thallium increases the thermo-emf in the presence of a constant hole concentration and accelerates the rate of increase in R with temperature. This is satisfactorily explained by the model of a quasilocal impurity band located in the background of the valence band. The impurity band is narrow and partially (half) occupied by thallium electrons; this accounts for the marked increase in the solubility of excess lead upon doping with thallium. Figures 2; references: 5 Russian.
[181-1386]

PROPAGATION RATE OF THE ONE STATE IN A pnpn-TYPE SWITCH IN THE PRESENCE OF A HIGH CURRENT DENSITY

LEVINSHTEYN, M. YE. and SHENDEREY, S. V., Leningrad, Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract]   The phenomenological theory of the propagation of the one state in pnpn-type switches satisfactorily describes all the known experimental facts but one: theoretical field-model calculations predict the saturation of the propagation rate of the one state V at the current density $J \gtrsim 5 J_0$, where J_0 is the current density at which the one state does not propagate but occupies only part of the area of the p-n-p-n structure. In reality, however, experiments show that the propagation rate at $J > J_0$ at first rapidly increases within the range of $J_0 < J \lesssim (5-10) J_0$, which is in good agreement with theory, but subsequently, as the current density further increases, the propagation rate continues to increase, although slowly: when j increases by 2-4 orders of magnitude, V increases by a factor of 2-3 times. It is shown that the reason for this is that, contrary to the findings of earlier investigators, the time constant of the increase in current in the one state decreases with increase in J owing to the voltage drop at the thyristor V_0 and this should be accompanied by a slow increase in V with increase in current density, as has indeed been observed

experimentally. By the same token it can be expected that the density of
the critical charge required to reverse the pnpn-type switch should
decrease with increase in V_0. Figures 2; references 7: 5 Russian, 2
Western.
[181-1386]

PHOTOCONDUCTIVITY OF LITHIUM-ION-DOPED DIAMONDS IN THE IR REGION

VAVILOV, V. S., KONOROVA, YE. A., STEPANOVA, YE. B. and TRUKHAN, E. M.,
Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The doping of insulating diamonds with lithium ions is known
to result in relatively low-resistance layers of n-type semiconductor
diamond with a crystal structure that is recovered after annealing. Research
into the photoconductivity of such layers is of major interest, since it can
provide information on the position which the impurity levels and radiation
defects introduced during the doping occupy in the forbidden band. Accord-
ingly, the photoconductivity of diamond specimens doped with lithium ions
was measured in a specially designed microwave set-up in the IR region.
For all specimens the photoconductivity spectrum was found to consist of
three wide bands--I, II, and III, at energies of 0.40-0.31, 0.20-0.16 and
0.14-0.09 eV, respectively. The position of the longwave edge of band III
in the spectra for all the specimens investigated is in good agreement with
the value of the thermal activation energy of electrical conductivity in
the presence of low-frequency alternating current. Hence it can be con-
cluded that band III in the spectrum of photoconductivity is associated with
the lithium level in the diamond. The observed band represent envelopes of
complex line structure. Figures 3; references 9: 7 Russian, 2 Western.
[181-1386]

SEMICONDUCTOR-METAL SEMICONDUCTOR TRANSITIONS IN $Pb_{1-x}Sn_xTe(In)$ ALLOYS UNDER THE ACTION OF PRESSURE

AKIMOV, B. A., ZLOMANOV, V. P., RYABOVA, L. I., CHUDINOV, S. M. and YATSENKO, O. B., Moscow State University imeni M. V. Lomonosov

[Abstract] Oscillatory and magnetoresistive effects were investigated in $Pb_{1-x}Sn_xTe$ ($0.21 \lesssim x \lesssim 0.30$) alloys containing ~ 0.5 atm.% In under pressures of up to 18 kbar in magnetic fields of up to 40 kilo-oersted within a broad range of temperatures (2-300 K). The alloys with p-type conductivity were found to display dielectric-metal transitions analogous to those known for alloys with n-type conductivity. A systematic investigation of the alloy system $Pb_{1-x}Sn_xTe(In)$ ($0.21 \lesssim x \lesssim 0.30$) made it possible to determine the characteristics of both electrons and holes over a broad range of Fermi energies (3-30 meV) and for various values of forbidden-band width. The parameters of the two-band model of the spectrum of $Pb_{1-x}Sn_xTe$ alloys, serving to describe with satisfactory accuracy all the derived experimental dependence, were computed. The baric coefficient of motion of the impurity level relative to the middle of the forbidden band was determined as a function of the alloy composition. It was shown that the In level gets displaced by pressure in the direction of the nearest forbidden band, so that as a result the conductivity type of the alloy does not change throughout the range of pressures applied. The semiconductor-metal-semi-conductor transition occurring under the action of pressure in these alloys is accompanied by topological transitions with the formation of electron or hole ellipsoids at points in the Brillouin L-band when $p = p_1$ and with the disappearance of these ellipsoids when $p = p_2$. Figures 6; references 11: 9 Russian, 2 Western.
[182-1386]

GENERATION OF COHERENT RADIATION IN A SYMMETRICIZED VARIBAND WAVEGUIDE

GUTOV, V. V., IMENKOV, A. N., KONDRAT'YEV, B. S., POPOV, I. V., TSARENKOV, B. V. and YAKOVLEV, YU. P., Leningrad, Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] It is known that coherent radiation can be generated in a vari-
band p-n structure based on $Ga_{1-x}Al_xAs$. In such a structure that radiation
can be coherent throughout the volume of the active layer; however, the
variband waveguide built on the basis of this structure is asymmetrical
relative to the middle of the active layer. In this context, symmetrici-
zation of the variband structure with respect to the middle of the active
layer of the waveguide is desirable, since it enhances the quantum yield
of coherent radiation and assures a fit between the peak of electrical
field distribution of the waveguide mode of that structure and the middle
of the active layer. The authors have developed such a symmetricized vari-
band waveguide structure on the basis of an epitaxial $Ga_{1-x}Al_xAs$ with two
variband regions adjoining the active region; in these two variband regions
adjoining the active region; in these two variband regions the width of the
forbidden band increases with increasing distance from the active layer.
Such a structure, with an active-band width of $1-1.5 \mu$ m, has assured the
generation of coherent radiation at a threshold current density of 4-8 kA/
cm^2 and at 293 K temperature. The loss coefficient and amplification con-
stant of the active medium were 16-18 cm^{-1} and $0.6-1.6$ $cm^{-1} \cdot (cm^2 \cdot \mu m/kA)^{2.5}$,
respectively. The radiation spectrum was multimodal with a maximum at
1.40 eV and a half-width of 1.5-2 meV. The spatial distribution of the
radiation reveals the presence of transverse modes with a wave vector hav-
ing not only a component parallel to the plane of the waveguide layer but
also a component at right angles to that plane. Figures 4; references 5:
4 Russian, 1 Western.
[182-1386]

DETERMINATION OF THE LIFETIME OF NON-EQUILIBRIUM CARRIERS IN STRONGLY
EXCITED CdS_xSe_{1-x}

KOZLOVSKIY, V. I., NASIBOV, A. S. and REZNIKOV, P. V., Moscow, Physics
Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Experimental findings showing that the lifetime of non-
equilibrium charge carriers $\mathcal{T}$, which generally is a function of their
density n, remains virtually unchanged in CdS_xSe_{1-x} crystals with increase
in concentrations to 10^{19} cm^{-3}, and remains at the level of $\sim 10^{-9}$ s
within the 80-300 K temperature range. $\mathcal{T}$ was determined by a technique
based on measuring the threshold pumping rate of a laser screen constructed
from these crystals, as a function of the duration of the scanning rate of
the exciting electron beam. Thus the possibility of achieving high

9

concentrations of non-equilibrium charge carriers (10^{18}-$2 \cdot 10^{19}$ cm^{-3}) in CdS$_x$Se$_{1-x}$, owing to the attendant weak $\tau(n)$ dependence, has been experimentally demonstrated. Figures 3; references 9: 6 Russian, 3 Western. [182-1386]

INFLUENCE OF RESONANCE INTERACTION ON THE STARK EFFECT FOR CERTAIN
IMPURITY CENTERS IN MOLECULAR CRYSTALS

VALKUNAS, L. and SUGAKOV, V. I., Institute of Physics, Lithuanian SSR
Academy of Sciences; Kiev State University imeni T. G. Shevchenko

[Abstract] The Stark effect was investigated for an impurity center in a
naphthalene crystal on assuming that the impurity lacks an inversion center
and undergoes a linear Stark effect. The calculations were made with
allowance for orienting an electrical field along the b-axis of the crystal,
and they show that the dependence of the position of level on field intensity is complex and differs from both linear and quadratic dependences,
inasmuch as the investigated system consists of two interconnected subsystems one of which (the impurity) undergoes the linear Stark effect and
the other (the local exciton), the quadratic. This analysis of the model
of the impurity center in molecular crystals, based on the assumption that
the impurity has a level close to the level of the local exciton which it
generates and, further, that the intensity of light absorption by the
impurity molecule is markedly higher than the intensity of light absorption
by the molecules of the crystal, can serve as a recommendation for possible
experimental measurements. Figures 4; references 6: 5 Russian, 1 Western.
[16-1386]

SPACE CHARGE OSCILLATIONS CAUSED BY CUMULATIVE IONIZATION IN A HOMOGENEOUS
SEMICONDUCTOR

VASILETS, O., BLONSKIS, V., POZHELA, YU. and REPSHAS, K., Institute of
Semiconductor Physics, Lithuanian SSR Academy of Sciences

[Abstract] High-frequency oscillations of current are known to occur in "waist-type" semiconductor specimens. These oscillations occur at two frequencies: "low," of the order of 0.5 Ghz, and "high," of the order of 4 GHz. Proceeding from the premise that these oscillations are associated with cumulative impact ionization in the region of the maximum intensity of the electrical field at the anode, the attendant processes in a homogeneous, isotropic semiconductor with a varying cross section are numerically analyzed. A model qualitatively describing both "low-frequency" and "high-frequency" oscillations is presented. When the electrical field intensity at the anode is sufficiently high to cause cumulative impact ionization, a hole packet is generated and, moving toward the cathode, compensates the space charge in the "waist" of the specimen, which results in reducing the field maximum E_{max} below the critical value. When the space charge at the waist is restored, E_{max} reaches its breakdown value and the process is repeated. This accounts for the "high-frequency" oscillations. If the current is such that cumulative ionization is not discontinued in the part of the specimen where the field is maximal, the oscillations have a much smaller period than the transit time of the hole packet across the waist part of the specimen. This accounts for the "low-frequency" oscillations. Figures 5; references 8: 5 Russian, 3 Western.
[16-1386]

USSR

POLARIZED ELECTROLUMINESCENCE OF GALLIUM NITRIDE

SHAGALOV, M. D. and DRIZHUK, A. G., Volgograd Polytechnic Institute

[Abstract] Effective polarized electroluminescence (EL) of gallium nitride treated with zinc is here discovered in the entire visible wavelength region. The possibility of obtaining radiation of various colors in GaN: Zn is due to the features of incorporation of zinc into the GaN lattice depending on the growing conditions as well as to the proneness of zinc toward complexing. In this connection, the electrophysical properties of GaN n-i structures whose EL displays an emission intensity maximum at $\sim$ 2.55 eV were investigated. In particular the luminescent properties of GaN:Zn point to the existence of still unknown mechanisms of emission processes with the participation of centers of the dipole type and provide some information on the structure of the zinc complex. A distinguishing feature of the EL of GaN is that it changes when the GaN crystal is placed in a magnetic field: emission intensity roughly doubles in magnetic fields of $\sim$ 10 kilo-oersted. Emission in blue photodiodes arises already at

comparatively low electrical field intensities of $\sim 4 \cdot 10^4$ v/cm and only in the presence of a positive potential at the i-layer of GaN. For the yellow, green, and blue LEDs emission is most effectively generated at $\sim 5 \cdot 10^5$ v/cm. It can be assumed that zinc complexes of the dipole type are responsible for the polarized blue emission of GaN:Zn. Figures 2; references 6: 3 Russian, 3 Western.
[160-1386]

USSR

PHOTOVOLTAIC EFFECTS IN BISMUTH SILICATE ($Bi_{20}SiO_{20}$)

PETROV, M. P. and GRACHEV, A. I., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] Photovoltaic effects (PVE) arising under illumination with linearly and circularly polarized light have been observed or predicted in a number of materials. In this connection, the authors observed both these sources of PVE (henceforth termed "linear" and "circular" PVE) in a $Bi_{12}SiO_{20}$ crystal belonging in the cubic point group 23. The experiments were performed on an undoped $Bi_{12}SiO_{20}$ crystal having the shape of a plate cut at right angles to the [100] axis. An argon laser was used as the light source. The mechanism of the "linear" PVE in $Bi_{12}SiO_{20}$ may be described on the basis of the model proposed by E. M. Baskin et al. (FTT, Vol 20, 2432, 1978) for the case of impurity absorption in crystals lacking an inversion center. The asymmetry of electron distribution in this case is produced by the distortion of the wave function of electrons by the impurity field associated with its octupole moment. The elucidation of the possible mechanism of "circular" PVE is more difficult in view of the lack of precise data on the band structure of the $Bi_{12}SiO_{20}$ crystal, but this mechanism may be associated with the low mobility and high effective mass of electrons in such crystals. Figures 2; references 9: 4 Russian, 5 Western.
[160-1386]

DETERMINATION OF THE POSITION OF LEVELS IN THE SPIN SUB-BANDS OF FERRO-
MAGNETIC COBALT WITH THE AID OF EXPERIMENTS UNDER PRESSURE

VINOKUROVA, L. I., GAPOTCHENKO, A. G., ITSKEVICH, YE. S. and
KULATOV, E. T., Institute of Physics of High Pressures, USSR Academy of
Sciences

[Abstract] Cobalt is the least investigated of the three ferromagnetic 3d-
metals, and the number of studies of its electron structure is much smaller
than for Fe and Ni. In the experimental plane this is chiefly due to the
difficulty of obtaining perfect crystals, and in the theoretical, to the
complexity of the band structure of cobalt. In this connection, pressure
was used as a parameter for affecting the Fermi surface cross sections.
The De Haas-Van Alfven effect was measured under a pressure of up to 11
kbar on $1x1x4$ mm^3 specimens having the shape of parallelpipeds. The
experimentally obtained values of the baric derivatives of Fermi surface
cross sections warrant the conclusion that the cross section α belongs in
the hole surface and exists in the band with a low occupation number, while
cross section β belongs in the electron surface in the band with a high
occupation number, and hence that the latter surface has open trajectories
along [0001]. Figures 1; references 12: 4 Russian, 8 Western.
[160-1386]

EXPERIMENTAL DISCOVERY OF CRYSTALLIZATION WAVES IN He^4

KESHISHEV, K. O., PARSHIN, A. YA. (Institute of Crystallography, USSR
Academy of Sciences) and BABKIN, A. V., Institute of Physics Problems,
USSR Academy of Sciences

[Abstract] Helium crystals are known to display unusual properties such
as the anomalously rapid "healing" of an impression made with the aid of an
indentor at the boundary between two phases (A. F. Andreyev and A. Ye.
Parshin, PIS'MA V ZHETF, 75, 1511, 1978). It is thought that the equilib-
rium boundary between liquid and solid helium may exist in a special state
representing a quantum analogue of an atomically rough surface. Such an
assumption implies, in particular, that at such a surface crystallization
waves--slowly decaying oscillations due to alternating melting and

recrystallization--may exist at temperatures markedly below the λ-point. In this connection, the existence of such crystallization waves was experimentally investigated on specially grown He^4 crystals in which surface oscillations were excited with the aid of a copper-wire capacitor and observed with the aid of a motion picture camera. The spectrum of these oscillations, as measured by means of diffracting the light of a He-Ne laser on a surface wave, indeed demonstrated the existence of the predicted weakly decaying fluctuations of the boundary between liquid and solid He^4 at 0.4-0.6 K--the crystallization waves. Figures 3; references 6: 3 Russian, 3 Western.
[160-1386]

USSR

COHERENCE EFFECTS DURING LOSS OF ELECTRONS BY CHANNELED IONS

BAZILEV, V. A. and ZHEVAGO, N. K., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Collisions of fast heavy ions with individual atoms in a crystal and attendant formation of electron vacancies in the shells are considered, particularly when an ion moves through a crystal in the channeling mode and travels a far distance along a nearly straight line at a constant velocity. Collisions with atoms are then correlated in time, which affects the probability of electron loss by such an ion. An analysis of these effects in terms of coherent excitation and coherent ionization indicates a substantial role of thermal vibration of atoms in a crystal. The analysis involves calculating the potential of electron-crystal interaction and the probabilities of electron transitions from a quasi-discrete level to either another quasi-discrete excitation level or an ionization level with a continuous energy spectrum. For a multiply charged channeled ion with more than two bound electrons in its shells and subject to the Massey criterion of nonadiabaticity, the probability of loosing electrons due to resonant excitation is found to become higher, but not so high in the outer shell. This follows from the solution to the Schrodinger equation for the wave function of an electron, applied to only one harmonic of the interaction potential and assuming a lifetime of the excited state comparable to or shorter than the ion transit time. This method is applicable only to sharp resonance, not wider than the energy difference between successive harmonics of the periodic crystal interaction potential. References 16: 8 Russian, 8 Western.
[176-2415]

SPECIFIC FEATURES OF THE PASSAGE OF A LOW CURRENT ELECTRON BEAM THROUGH GASES

PAL', A. F., PERSIANTSEV, I. G., PETRUSHEVICH, YU. V. and A. N. STAROSTIN, Scientific Research Institute for Nuclear Physics and Moscow State University imeni M. V. Lomonosov, presented by Academician Ye. P. Velikhov, 19 Feb 79

[Abstract] An electron beam is introduced into a discharge chamber with dimensions of 1 x 1 cm through a grid which is connected to the grounded housing for the beam and which serves as the discharge chamber cathode. The electron collector, the anode of the quartz discharge chamber, is on the opposite side from the grid cathode and grounded through a load resistor. The electron beam was supplied by 120 kV AC. An oscilloscope trace shows the change in the collector potential which is proportional to the current through the discharge gap, filled with air at 1 atm. The width of the current pulse of the beam is determined by the material and thickness of the foil separating the vacuum volume of the beam and the discharge chamber. A foil of the alloy Al + Be with a thickness of $4-5$ mg/cm^2 was used. Oscilloscope traces are also shown for a chamber pumped down to 10^{-1} torr, filled with CO_2 at atmospheric pressure and filled with argon. It is shown that the current flowing through a chamber filled with gas depends greatly on the type of gas and can differ in the direction of flow, because of which, under certain conditions the chamber becomes a voltage source capable of delivering current to a load. The "back current" which is responsible for this positive potential at the collector depend on the purity of the gases used, increasing in the case of pure gases, as well as the purity and the material of the collector surface, being higher where the collector surface was cleaned of the oxide film. These effects are analyzed mathematically by breaking the volume of the discharge chamber down into three sections: 1. a narrow section, the gap close to the surface of the grid through which the fast electrons pass into the chamber (the "cathode" region); 2. the "positive column", which occupies the major portion of the discharge chamber; 3. an "anode" region, which is the narrow gap close to the fast electron collector. Good agreement is noted between the experimental data and the derived analytical expressions; the measurement of electron beam currents using an electron collector configuration must be used when the beam travels through air or a vacuum chamber at a pressure of no more than 10^{-1} torr. The radiation with the passage of the beam through various gases can provide information on the processes occurring in these gases. Figures 3; references 5: 2 Russian, 3 Western.
[179-8225]

YELEONSKIY, V. M., KIROVA, N. N. and KULAGIN, N. YE.

[Abstract] Self-localized solutions to the Landau-Lifshits equations,
applicable to the theory of moving domain walls in magnetically ordered
media and useful in the search for magnetic solutions, yield for waves
with a steady profile propagating through a ferromagnetic normally to the
anisotropy axis not only a law of conservation associated with the invari-
ance of Lagrange functions but also another one associated with the first
integral. The existence of a new first integral has already been demon-
strated by numerical analysis and is confirmed here by analytical calcula-
tions for a uniaxial ferromagnetic. On the basis of this new law of con-
servation, the depencence of the amplitude of a slow or fast solution
on its velocity and on the medium characterizing parameter is now estab-
lished in explicit form. A more precise numerical calculation of the
anisotropy energy has, furthermore, revealed a breakup of level surfaces
for this new first integral. The authors thank V. I. ARNOL'D for suggest-
ing how to solve the problem and I. YE. DZYALOSHINSKIY for the discussion
of this study and the constant support. Figures 1; references 2: 1 Russian,
1 Western.
[176-2415]

THE STRUCTURE OF SHOCK WAVES IN A DIATOMIC RADIATING RAREFIED GAS

KUZNETSOV, N. M., POPOV, V. M. and KHODYKO, YU. V., USSR Academy of
Sciences Institute of Chemical Physics, Moscow and the Institute of Physics
of the Belorussian Academy of Sciences, Minsk, presented by Academician
V. N. Kondrat'yev, 8 Feb 79

[Abstract] Radiative heat exchange in the infrared region of the spectrum
becomes an important factor governing the change in the vibrational energy
close to a shock wave when the wave propagates in a low density molecular
gas. The relaxation structure of a shock wave, taking radiation into
account, is analytically studied to determine the distribution of the vibra-
tional energy ahead of the shock wave front and the influence of prelimi.ary
excitation on the wave structure behind the front, in cases where the shock
wave intensities are such that dissociation and electron excitation are
still insignificant. The case of one-dimensional steady-state gas flow is
treated. Analytical expressions are derived which describe the relaxation
of the vibrational energy in the radiating gas and the integral flow S
and an integral radiation density V as a function of the coordinates
referred to the shock wave front. Curves are plotted for S, the vibra-
tional motion temperature and the gas temperature as a function of the
distance in meters from the shock wave, for the case of CO where $T_1 = 273^\circ$ K,
the density is about 10^{-7} g/cm^3 and $T_\infty = 4,500^\circ$ K. In step with the dis-
tance from the shock wave, radiation absorption also continues in a gas
subjected to shock compression. The temperature difference between vibra-
tional and translational motion decreases simultaneously, while the radia-
tion flux reaches a maximum. In the case of nonequilibrium, only with
radiation does the maximum of the flux always coincide with the shock wave.
The values of the temperatures and densities at which the role of radia-
tion is important are determined by the ratio between the unidirectional
"equilibrium" radiation flux and the gas dynamic flux. A simple expression
is given which defines this ratio and the significance of the part played
by radiation. Figures 1; references: 2 Russian, 2 Western.
[179-8225]

UDC 532.526:533.6.011.72

FLOW PATTERN IN THE SEPARATION ZONE DURING INTERACTION OF A FORWARD
DENSITY JUMP WITH THE BOUNDARY LAYER IN A CORNER

ZUBIN, M. A. and OSTAPENKO, N. A., Institute of Mechanics, Moscow State
University, Moscow

[Abstract] An experimental study was made of separation flow in a corner
between two flat plates following interaction of a forward incident density
jump and the boundary layer in that corner. One plate was laid parallel to
the stream at the bottom and the other plate was rotated to form any
dihedral angle, to thus yield various angles of attack with resulting
density jumps of different magnitudes but always occurring within a turbu-
lent boundary layer.   velocity of the stream prior to incidence was
Mach $N_{Ma,\infty}$ = 2.95, th   ds number in the corner varied over the N_{Re} =
$(1.5-2)\cdot10^6$ range. A special optical shadow method of flow visualization
was combined with visualization through a cloud of oil and soot, also with
drainage through holes in two sections of the bottom plate. Pressure rela-
tions and profiles have been determined as a result. The conical flow
pattern was found to become distorted, with the separation pressure ratio
being almost independent of the local Reynolds number but depending only
on the local Mach number in the direction normal to the separation line.
Changes in the flow pattern were found to occur at some critical pressures,
depending on the angle of attack, and the 20° angle of attack to mark a
transition between different modes of interaction between the oncoming
stream and the boundary layer. Figures 5; references 19: 9 Russian,
10 Western.
[5-2415]

UDC 532.528.011

OBLIQUE ENTRANCE OF A THIN BODY WITH AN OPEN CAVITY INTO AN IDEAL WEIGHT-
LESS FLUID

TERENT'YEV, A. G., Cheboksary

[Abstract] A thin body defined in a movable system of coordinates moves
relative to a stationary system of coordinates with some linear velocity
and some angular velocity. Asymmetric entrance of this body into a fluid

with a cavity forming in the wake is formulated as a boundary-value problem with respect to the time derivative of the potential function in the complex plane, this problem being reducible to a Volterra integral equation of the first kind. The potential function is sought and the equation subsequently solved for a semiinfinitely long plate entering obliquely at a constant velocity with a cavity forming at the underside only as well as for a finitely long wedge entering vertically but sideways at a constant velocity, in the latter case a cavity forming only after the entire wedge has immersed. The potential function, with the aid of the linearized Cauchy-Lagrange equation, yields the longitudinal pressure distribution over the body and the transverse force acting on it. This integral equation has been solved numerically by the method of successive approximations. Figures 5; tables 1; references 9: 7 Russian, 2 Western.
[5-2415]

BACSINA, I. A., DOROT, V. L. and STRELETS, M. KH., Leningrad

[Abstract]   Under consideration are supersonic chemical (HF and DF) continuous-wave diffusion lasers. A method is proposed for calculating the parameters of a multicomponent boundary layer in a flat supersonic laser nozzle, with injection of cooling gas through a porous wall and with heterogeneous chemical reactions occurring at the walls. Such an N-component boundary layer is described by a system of $N+5$ gas-dynamic and thermodynamic differential equations in six variables, supplemented by the Stefan-Maxwell relations for each component, with the appropriate boundary conditions. After transformation from orthogonal space coordinates to Dorodnitsyn coordinates according to Liese, these equations are solved by asymptotic approximation and numerical integration. Calculations have been made for an $F + F_2 + HF + He$ mixture with only a single dissociation-recombination reaction $F + F + X = F_2 + X$. With the aid of the results it is possible to analyze the back effect of the boundary layer on a nonviscous stream, the effect of catalytic activity of the wall material on the flow characteristics, and the effect of wall cooling on the characteristics of the boundary layer. The boundary layer is found to reduce the effective nozzle expansion ratio so as to raise the pressure and lower the Mach number in the main stream. The catalyticity of nozzle walls lowers the concentration of atomic fluorine in the boundary layer with rising wall temperature,

its effect on the temperature profile and the velocity profile being less
appreciable but still significant. Cooling with injected helium is very
effective but also increases the thickness of the boundary layer (dynamic,
thermal, diffusion) and thus adversely affects the laser power character-
istics so that the optimum injection rate must be found in the tradeoff.
Figures 4; tables 1; references 15: 6 Russian, 9 Western.
[5-2415]

FEASIBILITY OF INJECTING A GAS JET INTO A SUPERSONIC STREAM WITHOUT
FORMATION OF A THREE-DIMENSIONAL ZONE OF BOUNDARY-LAYER SEPARATION

MASYAKIN, N. YE. and POLYANSKIY, M. N., Moscow

[Abstract] Interaction of a supersonic stream with a transversely injected
sonic or supersonic jet is considered, for the purpose of determining the
nozzle outlet geometry which will yield a flow pattern without a three-
dimensional zone of boundary-layer separation. In an experimental study by
the photographic method a sonic jet ($N_{Ma} = 1$) and a supersonic jet ($N_{Ma} = 2.9$) were injected through nozzles with triangular (isosceles with 10°, 20°,
40° vertex angles) and equivalent circular outlet sections into a stream
with the Mach number $N_{Ma,\infty}$ varied from 2.1 to 3.7 and the Reynolds number
ranging from $2 \cdot 10^6$ to $2 \cdot 10^7$ along the guide plate up to the separation line
in the plane of flow symmetry. The results reveal relations from which the
necessary location of the principal density jump can be determined, depend-
ing on the velocity of the stream and taking into account the nozzle
inefficiency. Figures 5; references: 3 Russian.
[5-2415]

A METHOD OF CALCULATING THE POTENTIAL FLOW AROUND A SYSTEM OF AIRFOILS IN
AN INCOMPRESSIBLE FLUID

ZAYTSEV, A. A. and KOMAROV, A. M., Department of Aeromechanics and Gas
Dynamics

[Abstract] A slotted airfoil with an infinite span has an arbitrary number
of aerodynamic profiles. Fredholm equations of the second kind are written
for the flow of an incompressible,ideal fluid over the airfoils, using the
vortex layer method. The equations are solved numerically by iteration for
each profile in succession. The iteration program was composed in ALGOL-
CDR language for the BESM-6 computer. The theoretical procedure is com-
pared with the precise results obtained for a wing and flap, studied
in earlier literature. The calculation was performed for an attack angle
of zero at 140 points on the wing and 120 points on the flap. Pressure
are shown graphically for the wing and the flap, giving the data from
exact solution, the proposed procedure and the method used previously.
The calculation error ranged from 0.68 to 3.59 percent for the proposed
procedure, as contrasted with 4.10 to 13.90 percent for the previous method,
where both are compared with the exact solution. Figures 2; references 7:
4 Russian, 3 Western.
[189-8225]

USSR

THEORY OF NORMAL IONIZING SHOCK WAVES

LIBERMAN, M. A., Institute of Physical Problems, USSR Academy of Sciences

[Abstract] A theory of normal ionizing shock waves is constructed which
takes into account the energy of gas ionization and dissociation. It is
based on a single constraint, namely stability of stationary structures and
thus ionization stability of the gas before the wave front. The equations
of conservation and the boundary conditions are derived from the Maxwell
field equations and the continuity equation. The various magnetic struc-
tures depending on the relative magnitudes of the acoustic and the magnetic
Mach numbers are established in the case of weak ionization and in the
case of strong ionization respectively. Following these general considera-
tions, the formation of shock waves in an electromagnetic shock tube is
analyzed on the basis of a simple elementary model of a magnetic piston, a
modification of the "snowplow" model. The only stable configuration here
is found to be a fast shock wave followed by a slow rarefaction wave, a
nonseparating Chapman-Jouguet shock wave being the extreme case and slow
shock waves being unstable. Another boundary condition is established,
moreover, namely that the electric field intensity before the wave front
has reached the level at which the gas breaks down. Accordingly, a sta-
tionary structure is always possible in the case of a transverse ionizing
shock wave with the magnetic field in the plane of the wave front, but is

possible only with preionization in the case of a driver shock wave. The plasma parameters of hydrogen and helium as well as the structural characteristics of a normal ionizing shock wave in a quasi-neutral plasma are calculated on the basis of this theory. The results for a normal ionizing driver shock wave are approximate, but close to experimental results. The author thanks A. L. VELIKOVICH for the fruitful discussions, also YA. B. ZEL'DOVICH and P. L. KAPITSA for the helpful comments. Figures 10; references 28: 6 Russian, 22 Western.
[176-2415]

THE DETERMINATION OF THE TEMPERATURE OF HYPERSONIC WAKES USING THE
METHOD OF RELATIVE INTENSITIES

MISHIN, G. I. and YAVOR, I. P., USSR Academy of Sciences Engineering
Physics Institute imeni A. F. Ioffe, Leningrad

[Abstract] A spherical copper-plated Duralumin projectile 10 mm in diameter, which was coated with a film containing cesium salts, was fired into an altitude chamber filled with a mixture of air and xenon. The temperature of the wake was determined from the two spectral lines of the cesium atom at wavelengths of 5,663 and 7,609 $\mathring{A}$. The energy difference between the upper levels of these spectral transitions is 0.56 eV. A monochromator recorded the radiation from the wake, and photomultipliers were located at the two output slots of the monochromator. A dual trace oscilloscope was used to observe the outputs of the photomultipliers. The oscilloscope was triggered by a synchronization unit just slightly before the projectile intersected the optical axis of the monochromator. Oscilloscope traces of the variation in the intensities of the spectral lines from the hypersonic wake of the projectile flying at a velocity of 3,400 m/s in a mixture of 65% and 35% xenon at a pressure of 69 torr are shown. A formula is given for the determination of the wake temperature based on these traces. The average error was about 20%. It should be noted that a temperature determined in this way is an averaged value in a plane transverse to the axis of the wake, but since the greatest contribution to the radiation is from the hottest regions of the wake, the measured temperature reflects the state of just these regions. The radial distribution of the temperature in axially symmetric wakes can be found from profiles of the spectral line intensities perpendicular to the wakes. This method of relative

intensities yields an excitation temperature of the comparatively higher
levels, which agrees with the gas kinetic temperature under thermodynamic
equilibrium conditions. In the case of significant deviations from equi-
librium, the temperature measured in this manner can serve for the analysis
of the population kinetics of the excited levels. Figures 3; references 6:
2 Russian, 4 Western.
[171-8225]

INFLUENCE OF REYNOLDS NUMBER ON PARAMETERS OF THE NEAR WAKE OF A BLUNT CONE

MIKHALEV, A. N., USSR Academy of Sciences Engineering Physics Institute
imeni A. F. Ioffe, Leningrad

[Abstract]   A model of a blunt cone with a half-angle of 15° was fired
through a ballistics test area instrumented with an interferometer,
Toepler's schlieren apparatus and a shadow indication instrument. The near
wake of the cone was measured at Mach numbers of 2.3 ± 0.2 and 4 ± 0.2; the
Reynolds numbers were varied from $8 \cdot 10^4$ to $2 \cdot 10^6$ by changing the air pres-
sure in the test area. The surface roughness of the metal models did not
exceed 1.6 micrometers. An interferometer picture, as well as shadow and
schlieren pictures were obtained for each trial, the decoding of which
yielded the density field and the geometrical characteristics of the near
wake of the cone. The experimental data yield a simple logarithmic expres-
sion which correlates the base density of blunted zones with the Reynolds
number. The influence of the Reynolds number on the base density is related
to the position of the laminar to turbulent flow transition points in the
flow. An increase in the Mach number from 2.3 to 4 causes the Reynolds
numbers to increas. 1.5 times, at which the transition point falls on the
surface of the cone; this data is in agreement with existing literature.
The geometric factors which account for either laminar or turbulent flow
are discussed in light of the experimental data. Figures 4; references 9:
8 Russian, 1 Western.
[171-8225]

UDSR

ON THE GENERATION OF ELASTIC WAVES BY BEAMS OF CHARGED PARTICLES IN STABLE LIQUIDS

VOLOVIK, V. D., KALINICHENKO, A. I., LAZURIK, V. D. and POPOV, G. F., Khar'kov State University imeni A. M. Gor'kiy

[Abstract]   A single phenomenological approach to the description of possible radiation-acoustic effects is proposed, specifically as regards sound emission related to microbubbles formed at points of local energy liberation. An analytical expression is derived for the thermo-acoustic signal in the three-dimensional case, where the following assumptions are made: 1. there is a sufficient number of microbubbles in the radiating region so that the signals from them overlap repeatedly; 2. the effective radiation time of a microbubble is small as compared to the duration of the overall acoustic signal. The estimates indicate that for microbubbles with radii of 10^{-7} to 10^{-6} cm, the duration of the output of a single microbubble is on the order of 10^{-11} to 10^{-10} seconds. This leads to the conclusion that the primary contribution to the hydrodynamic mechanism of elastic wave generation is made by quasistable microbubbles which simulate a thermo-elastic mechanism. The expression for the total acoustic signal excited by a beam of charged particles in liquids can be generalized to the case, where besides the thermal expansion of the volume of the interaction zone, additional expansion occurs by virtue of various phase conversions, including the formation of quasistable and pulsating cavities, as well as processes which involve the liberation or absorption of energy as a result of radiation-chemical or nuclear transformations. The proposed approach makes it possible, without specifying the nature of the microscopic radiators, to establish a relationship between the distribution of the energy absorbed in a target and the characteristics of the acoustic pulse, which appears as a result of the radiation exposure. References: 5 Russian.
[171-8225]

HETEROLASERS BASED ON $Pb_{1-x}Sn_xTe$ AND OBTAINED BY THE INSTANTANEOUS VACUUM SPUTTERING METHOD

GEYMAN, K. I., ZASAVITSKIY, I. I., MATVEYENKO, A. V. and SHOTOV, A. P., Moscow, Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The instantaneous vacuum evaporation (IVE) method of producing high-grade epitaxial layers of $Pb_{1-x}Sn_xTe$ displays definite advantages over the liquid-phase, molecular-beam, and vapor-phase methods of growing these layers, since then film thickness can be varied within the broad limits (~ 0.1-$10\,\mu$m) required for heterostructures, and the process of epitaxy takes place at relatively low (300-350°C) temperatures, which serves to markedly reduce the interdiffusion of components, which normally is extremely high in the case of $A^{IV}B^{VI}$ type semiconductors. Accordingly, the IVE method was used to construct heterolasers based on $Pb_{1-x}Sn_xTe$ with unilateral optical constraint for the 9-16 μm spectral region. The heterostructures were obtained by growing n-type epitaxial layers doped with indium ($x = 0.14$, 0.18) or bismuth ($x = 0.20$) on thallium-doped p-PbTe substrates. At low ($\leq$ 350°C) temperatures nondoped n-$Pb_{0.88}Sn_{0.12}Te$ layers could be grown on nondoped p-PbTe substrate as well. Optimal threshold current densities are determined as a function of the thickness of the active region and its majority carrier concentration. Figures 2; references 16: 5 Russian, 11 Western.
[181-1386]

SELF-MODE LOCKING IN CONTINUOUSLY PUMPED DYE LASERS

KOTOMTSEVA, L. A., LOYKO, N. A. and SAMSON, A. M.

[Abstract] A system of quasiclassical equations and a system of velocity equations describing the performance of a dye laser with a clarifying filter are both investigated from a unified point of view, with allowance for lumped and distributed losses. A circular traveling-wave laser with boundary conditions including the amplitude discontinuity of electrical field intensity due to the mirrors is considered, disregarding the phase change

at reflection. A time-independent solution of the pertinent quasiclassical equations is analyzed for stability, and is found to result in a steady-state pattern of regular pulse sequence. By contrast, the numerical solution of velocity equations results in an unstable pattern of development of pulsations with a time-dependent variation in their recurrence frequency. These findings point to the considerable effect of the relaxation times of polarization on the lasing mode. The formulas derived are useful for the selection of optimal conditions of the development of self-mode locking in lasers with and without clarifying filters. Figures 4; references 8: 4 Russian, 4 Western.
[177-1386]

EXPERIMENTAL INVESTIGATION OF FLUCTUATIONS IN THE RADIATION INTENSITY OF CADMIUM- AND SELENIUM-VAPOR CW LASERS

DYATLOV, M. K., KAS'YAN, V. G. and LEVIN, V. G.

[Abstract] CW gas lasers operating on cadmium and selenium vapors are convenient radiation sources for optical data processing systems. However, in quite a few cases requiring a high signal/noise ratio the high radiation noise level of lasers of the cataphoretic type restricts their applications. For a He-Cd laser, e.g. the radiation noise level at the 441.6 nm wavelength reaches 25%. In this connection, the fluctuations in the radiation intensity of He-Cd and He-Se lasers were investigated with the aid of a specially designed experimental test stand with the object of pinpointing the cause of that high noise level. It was found that the presence of a group of superposed wave oscillations (of the irregular traveling strata type) is characteristic of the positive discharge column in pure He when the pressure and discharge current are optimal for Cd- and Se-vapor lasers. The noise level of the He-Cd laser on the 441.6 nm line was found to be largely due to the oscillations excited as a result of the interaction of discrete waves from the group of superposed oscillations having a mean frequency of ~ 100 kHz. The decrease in noise level by two orders of magnitude upon modulating the discharge current by means of a signal with a specific frequency is attributable to the disappearance of beats upon the synchronization of strata. The difference in the pattern of noise between the He-Cd and He-Se lasers is attributable to the difference in their mechanisms of level populations. The Penning process, which determines the population of the upper laser levels in the He-Cd mixture, enhances the ionization instability of plasma. Figures 3; references 16: 6 Russian, 10 Western.
[177-1386]

USE OF FREQUENCY MODULATION OF RADIATION IN LASER GAS ANALYZERS

MUKHTAROV, R. I. and NIKOLAYEV, A. I.

[Abstract] Gas analysis, and in particular remote sensing of atmospheric
pollution, is a major problem of applied laser spectroscopy. In this con-
nection, two methods for using the frequency modulation (FM) of laser radia-
tion to determine the concentrations of the constituents of a gas mixture
on the basis of a system of linear equations are proposed. This is accom-
plished owing to the marked selectivity of signals on FM harmonics with
respect to discrete constituents of mixtures with low ($\mathcal{T} << 1$) and high
($\mathcal{T} \sim 1$) optical densities. Formulas for the harmonic amplitude of FM
in a photodetector signal are derived for the case of marked frequency
deviations. Compared with the differential absorption method, the FM
technique is particularly superior for remote sensing of a turbulent atmos-
phere. The proposed methods assure a sensitivity at least 3-5 orders of
magnitude greater, so that they can be used over considerable atmospheric
distances (1-100 km). Figures 2; references 11: 3 Russian, 8 Western.
[177-1386]

STATISTICAL METHOD OF CALCULATING THE EMISSION CHARACTERISTICS OF DYE
LASERS

KARPUSHKO, F. V. and KAZBERUK, A. V.

[Abstract] For an analysis of the spectral kinetics of laser emission dur-
ing the transient stage, the method of statistical moments is applied to
the balance equations for the mean radiation densities and the mean popula-
tions of energy levels. The transition frequency is regarded as a con-
tinuous random variable and the probabilities of transitions due to pumping
are taken into account. Calculations are based on the Edgeworth expansion,
of which only four terms need to be retained in the case of Gaussian emis-
sion lines characteristic of dye lasers. These calculations yield the time
characteristics of radiation spectra. Here typical results are obtained for
rhodamine 6G with either constant or variable (exponential pulse) pumping
and with a selector for limiting the luminescence spectrum. Figures 1;
references 9: 7 Russian, 2 Western.
[175-2415]

Magnetohydrodynamics

USSR

UDC 538.4

LAMINAR FLOW OF AN ELECTRICALLY CONDUCTING LIQUID THROUGH THE CHANNEL OF
A CYLINDRICAL LINEAR INDUCTION PUMP

Riga MAGNITNAYA GIDRODINAMIKA in Russian No 2, Apr-Jun 79 pp 86-88
manuscript received 9 Nov 78

KAPUSTA, A. B. and SHAMOTA, V. P.

[Abstract] Laminar flow of an electrically conducting viscous incompressible
fluid through the gap between two nonconducting thin and infinitely long
coaxial cylinders is considered. The inner cylinder is filled with a
ferromagnetic medium and the surface of the outer cylinder carries a dis-
tributed electric load of a uniform current density. The traveling external
magnetic field in this problem is replaced with the uniform magnetic field
of a long ring magnet moving parallel to the axis of the cylinders at a
certain velocity. The continuity equation for the magnetic field reduces
the system of second-degree differential MHD equations to a simpler form,
with the Hartmann number and the magnetic Reynolds number as well as the
N_{Eu}(Euler)·N_{Re}(Reynolds) complex as the only parameters. The velocity dis-
tribution is found on the basis of the appropriate boundary conditions, for
$N_{Ha}= 2$ and $N_{Ha}\neq 2$ respectively, and subsequently also the distribution of
magnetic induction. The solution is exact and simply arrived at, applic-
able to any value of the Hartmann number or of other parameters. Numerical
calculations indicate that large positive pressure gradients result in a
high flow intensity at the outer wall, because the density of electro-
magnetic forces decreases along the radius. Figures 3; references: 1
Russian.
[6-2415]

Molecular Physics

NUMERICAL SIMULATION OF THE BREAKDOWN OF A DENSE MOLECULAR GAS BY MEANS OF LASER RADIATION IN THE NEIGHBORHOOD OF A METAL SURFACE

MAZHUKIN, V. I., UGLOV, A. A. and ChETVERUSHKIN, B. N., Moscow, Institute
of Applied Physics imeni M. V. Keldysh, USSR Academy of Sciences

[Abstract] The optical breakdown of molecular nitrogen by laser radiation
with 1.06μ m wavelength is investigated by the numerical simulation method
in conditions in which the high pressure of the gaseous medium extensively
suppresses the processes of evaporation of the substance of the target, i.e.
in cases in which plasma can be produced without mechanical damage to the
target surface. It is assumed that thermionic emission from the surface of
the molybdenum plate directly affects the mechanism of the breakdown which
is known to be represented by the process of avalanche ionization in the
$P \gg 1$ atm pressure range. Corresponding equations of population balance
and energy balance as well as the Poisson equation are derived, and the
resulting boundary-value problem is solved by the finite-difference method.
It is concluded that: 1) breakdown at high pressures (100 atm) occurs at
distances of less than 1μ m from the target, i.e. nearly at the surface of
the target; 2) the breakdown of molecular nitrogen develops following its
nearly complete transition to the atomic state; 3) the breakdown of molec-
ular nitrogen can be interpreted as breakdown in a pulsed laser beam; 4)
the maximum surface temperature, ~ 0.4 eV, points to the presence of
developed evaporation of matter from the target surface, since the boiling
point of molybdenum is, even at $P = 1$ atm, somewhat higher—0.42 eV. Thus,
the hypothesis of thermionic emission as one of the possible mechanisms of
the breakdown of dense cold gases is confirmed. Figures 2; references 5:
3 Russian, 2 Western.
[180-1386]

COMPARISON OF THE EFFECTIVENSS OF EXCITATION OF VARIOUS TYPES OF VIBRATIONS OF THE CCl_4 MOLECULE IN A POWERFUL IR FIELD

VASIL'YEV, B. I., VISHNYAKOV, N. A., GALOCHKIN, V. T., GRASYUK, A. Z.,
DYAD'KIN, A. P., ZHIGALKIN, A. K., KOVALEVSKIY, V. A., KOSINOV, V. N.,
ORAYEVSKIY, A. N., SUKHANOV, A. N., and STARODUBTSEV, N. F., Physics Insti-
tute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The effectiveness of activation of a CCl_4 molecule through the excitation of particular types of vibrations at multiphoton absorption of the IR emission quanta is investigated as part of research into chemical reactions stimulated by laser radiation. In particular, the mean energies absorbed by the CCl_4 molecule upon excitation of the fundamental γ_3 and composite $\gamma_1 + \gamma_2 + \gamma_4$ vibrations up to the dissociation level are experimentally compared. These excitations were accomplished by means of radiation from a CO_2 laser (line P(26) band 00^01-02^00). In addition the proportion of captured particles was determined by the method of two-frequency saturation of the dissociation yield on using a XeCl laser as the second radiation source. It is established that the energy required to excite a CCl_4 molecule to the dissociation level depends on the type of vibrations excited. At excitation of mode γ_3 the molecule absorbs twice as many IR quanta as at excitation of composite vibration. This fact, along with the need to displace the wavelength of laser radiation in the "red direction" with respect to the line absorption band, apparently is a fundamentally important condition for increasing the quantum yield of the products of chemical reactions excited by an intense IR field. Figures 2; references 8: 6 Russian, 2 Western.
[160-1386]

USSR

LASER CONTROL OF THE PERMEABILITY OF A MOLECULAR SIEVE

KARLOV, N. V., MESHKOVSKIY, I. K., PETROV, R. P., PETROV, YU. N. and PROKHOROV, A. M., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The use of a laser to control the permeability of a porous structure of the molecular sieve type is here reported for the first time. Such control is accomplished by means of argon-laser resonance excitation of the electron terms of the molecules of gas diffusing through the sieve.. The experiment was conducted for porous membranes consisting 95% of quartz and displaying a monodisperse porous structure with a narrow pore size distribution reaching a maximum of 40 Å. The membrane was installed in the middle of a quartz cuvette into whose inlet compartment a portion of the investigated gas was supplied under a pressure of several torr. The outlet compartment was directly connected to the ionization chamber of a quadrupole mass spectrometer. Under these conditions the free path length of the gas molecules markedly exceeds the size of the pores in the partition and free molecular flow of the gas takes place (Knudsen diffusion or effusion).

The effect of laser radiation on the permeability of the membrane was investigated for molecular bromine Br_2, alone or in mixtures with HBr, SF_6, or Ar. It is established that laser radiation distinctly affects the permeability of the membrane to bromine without affecting its permeability to the solvent gases HBr and SF_6 and Ar. Heating of the membrane, on the other hand, enhances its permeability to all constituents of the gas mixture. Figures 3; references 6: 4 Russian, 2 Western.
[160-1386]

MEASUREMENT OF ^{240}Pu and ^{242}Pu FISSION CROSS SECTIONS WITH RESPECT TO THE
FISSION CROSS SECTION OF ^{235}U WITHIN THE 0.127-7.4 MeV NEUTRON ENERGY RANGE

KUPRIYANOV, V. M., FURSOV, B. I., MASLENNIKOV, B. K., SURIN, V. M. and
SMIRENKIN, G. N.

[Abstract] This is another in a series of studies of the fast-neutron
fission cross sections associated with a number of the isotopes of uranium
and plutonium. (Fursov, B. I., et al., ATOMNAYA ENERGIYA, Vol 43, No 3,
1977; Vol 43, No 4, 1977; Vol 44, No 3, 1978; "Trudy Konf. "Neytronnaya
Fizika", Moscow, TsNIIatominform. Vol 3, 1977). The measurements were per-
formed on electrostatic accelerators, using as the neutron sources the
reactions ^{7}Li (p, n) ^{7}Be (E_n = 0.127-0.342 MeV), T (p, n) ^{3}He (0.313-3.4 MeV),
and D (d, n) ^{3}He (3.6-7.4 MeV), with a detector consisting of two duplex
chambers which made it possible to investigate simultaneously the ^{240}Pu/
^{235}U and ^{242}Pu/^{235}U fission cross section ratios. The total error of the
measurements of the fission cross section ratios was 2-2.5% for the ^{240}Pu/
^{235}U ratio and 2.2-2.8% for the ^{242}Pu/^{235}U ratio. A table of absolute
values of these ratios is presented, along with a table of corrections for
errors of measurement of these ratios. References 12: 6 Russian, 6 Western.
[173-1386]

DESIGN CALCULATION AND EXPERIMENTAL STUDIES OF THE OPTIMUM OPERATIONAL
MODE OF THE IRT TEST REACTOR

KALIN'SH, D. O., PAVLOV, V. I., POSLYUCHENKO, R. YE. and SIMONOV, V. D.,
Institute of Physics of the Latvian Academy of Sciences and the All-Union
Red Banner of Labor Heat Engineering Institute imeni F. E. Dzerzhinskiy

[Abstract] The xenon-135 concentration in the research reactor of the
Institute of Physics of the Latvian Academy of Sciences gradually increases
over the weekly operational period following nightly shutdowns of the
facility. The high level of xenon poisoning at times delays bringing the

reactor up to nominal power. An alternative to passively waiting for the natural decontamination is proposed, which involves a reactor control program to assure a minimum of forced downtime and a maximum nominal power phase over the weekly operational cycle. Analytical expressions are derived for the requisite curtailment of the operating time and power during the days of the weekly cycle; optimum conditions are found and checked experimentally which hold the reactor poisoning within acceptable limits, allowing a reduction of 0.2-2.0 hours in reactor downtime per week. Figures 6; references: 2 Russian.
[13-8225]

USSR

PLASMA IN OPEN TRAPS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 30 Aug 79 p 4

[Text] Methods for obtaining high temperature plasma in open magnetic traps with the help of relativistic electron beams are being studied in the Institute of Nuclear Physics of the Siberian Department of the USSR Academy of Sciences.

Senior engineer E. Boyarintsev and senior scientist, Candidate of Physics and Mathematical Sciences V. Lagunov at the high-power "Akvagen" electron pulse generator.

CSO: 1862-P

ALPHA-DECAY OF GIANT RESONANCES OF Ni^{58} NUCLEI

VOLKOV, YU. M., IGNAT'YEV, A. I., KOLOMENSKIY, G. A., LAKOVICHEV, YE. P., MAKHENOVSKIY, YE. D., NADTOCHIY, A. V., POPOV, V. V., POMILENKO, V. P. and CHIZHOV, V. P., Institute of Nuclear Physics imeni B. P. Konstantinov, USSR Academy of Sciences

[Abstract] Research into the decay channels of giant multipole resonances provides important information on the discharge mechanism of the collective excitations of nuclei. In this connection, the proton and α-particle decay channels of electron excited giant resonances of Ni^{58} nuclei were investigated. The reaction cross sections of Ni^{58} (e, e'p) and Ni^{58} (e,e'a) were measured within the 12-35 MeV range of electron energies. The experimental findings were analyzed with the aid of virtual photon spectra computed in the Born approximation with distorted waves. The analysis revealed the existence of the electrical quadrupole (E2) giant resonance in the alpha-particle decay channel of giant resonances of Ni^{58} nuclei. The strength of E2, concentrated within the region of the 16 MeV excitation energy, accounts for 35-60% of the total strength of isoscalar E2 transitions. The relative alpha-decay rate of E2 also is high, which apparently indicates a nonstatistical mechanism of alpha-particle emission. Currently the results of analogous measurements for Ni^{60} nuclei are being processed. Figures 1; references 6: 1 Russian, 5 Western.
[160-1386]

INCLUSIVE FORMATION OF D-MESONS IN e^+e^- ANNIHILATION

KARTVELISHVILI, V. G., LIKHODED, A. K. and SLABOSPITSKIY, S. R., Tbilisi State University; Institute of High-Energy Physics

[Abstract] It is shown that the fragmentation functions of the c-quark (Q = c) involving the formation of a D-meson, as computed by Kartvelishvili et al. (PHYS. LETT., 78B, 615, 1978), is in good agreement with the new experimental findings on the inclusive formation of D-mesons in e^+e^- annihilation at energies of $\sqrt{S} \approx 7$ GeV. The e^+e^- annihilation reaction may generate not only pseudoscalar but also vectorial D^* mesons which subsequently decay

along the $D^* \to D + \pi$ (γ) channel. Thus, the inclusive spectrum of pseudo-scalar D-mesons should be represented by the sum of two terms. The 5.0 nbn cross section derived from averaging over the energy range $\sqrt{s} = 6\text{-}7.8$ GeV is in good agreement with the experimentally derived 4.8 ± 1.3 nbn (such agreement indicates that the formation cross-section of F-mesons and charmed baryons at these energies is small compared with the formation cross section of D-mesons). Figures 2; references 10: 1 Russian, 1 Polish, 8 Western.

[160-1386]

INVESTIGATION OF THE REACTION $\gamma p \to n \pi^+$ WITH POLARIZED PROTONS AND PHOTONS AT $E\gamma = 340$ MeV ENERGY

GET'MAN, V. A., GORBENKO, V. G., GRUSHIN, V. F. (Physics Institute imeni N. P. Lebedev, USSR Academy of Sciences), DERKACH, A. YA., ZHEBROVSKIY, YU. V., KARNAUZOV, I. M., KOLESNIKOV, L. YA., LUKHANIN, A. A., RUBASHKIN, A. L., SANIN, V. M., SOROKIN, P. V., SPOROV, YE. A. and TELEGIN, YU. N., Physico-Technical Institute, UkrSSR Academy of Sciences

[Abstract] The known multipole analyses of available experimental data on the photoproduction of pi-mesons on nucleons in the photon energy range ≤ 500 MeV are characterized by non-uniqueness of solutions and an irregular pattern of energy behavior in the neighborhood of the P_{33} resonance peak (~ 340 MeV). These shortcomings of the analyses are due to the incompleteness of experimental data and their systematic error. In this connection it was of interest to conduct new polarization experiments that would, on the one hand, augment the available data on the photoproduction process and, on the other, assure compatibility of the data. To this end, the first ever double-polarization experiment of the "beam-target" type was organized for the $\gamma p \to n \pi^+$ reaction at the energy $E\gamma =$ MeV. The use of a polarized proton target and a beam of linearly polarized protons resulted in obtaining information on three different polarization parameters simultaneously: Σ, the cross section asymmetries for linearly polarized protons; T, the asymmetries on polarized protons; and P, the polarizations of the recoil nucleon. Thus, the mutual compatibility of the values of all the polarization parameters was assured. References 8; 3 Russian, 5 Western.
[161-1386]

Optics and Spectroscopy

PHOTOLUMINESCENCE SPECTRA OF SOLID SOLUTIONS OF $(ZnSe)_{1-x}(GaAs)_x$

BALTRAMEYUNAS, R., VOYTSEKHOVSKIY, A. V., KUOKSHTIS, E. and TKACHUK, P. N., Vil'nyus State University imeni V. Kapsukas; Kiev State Pedagogical Institute imeni A. M. Gor'kiy

[Abstract] Photoluminescence spectra of solid solutions of $(ZnSe)_{1-x}(GaAs)_x$ in the presence of high excitation levels were investigated on single crystals of ZnSe and $(ZnSe)_{1-x}(GaAs)_x$ in which x-ray phase analysis corroborated the crystallization of solid solutions in the sphalerite structure. Single-photon luminescence was excited by means of the third radiation harmonic of a YAG:Nd^{3+} laser, with recording of the spectra by the photoelectric method. As the GaAs concentration in the solid solution increases, there appears a new longwave radiation band whose maximum shifts in the direction of the long spectral waves with increase in x. The formation of a heterovalent-substitution solid solution at x $\gtrsim$ 0.06-00.7 is established. In addition, investigation of the radiation spectra of a thin ($\approx 3\mu$m) epitaxial ZnSe layer on a GaAs substrate indicates that at the interface there forms the solid solution $(ZnSe)_{1-x}(GaAs)_x$ with a GaAs content of the order of 3.0 mol.%. Apparently, the high epitaxial growth temperatures (1070-1130 K) contributed to an effective interdiffusion of the materials and to the formation of a heterovalent-substitution solid solution at the interface. These findings point to the need for further research into the ZnSe-GaAs system. Figures 2; references 6: 3 Russian, 3 Western. [182-1386]

SPECTRAL DIAGNOSIS OF A STABILIZED ARGON-AIR ARC

AUZINYA, L. K. and LIYEPINYA, V. E., Institute of Physics of the Latvian Academy of Sciences

[Abstract] An argon arc was stabilized with an air vortex in a quartz cylinder 25 mm in diameter; the argon rate of flow was 1.5 g/s and 2.5 g/s for the air. The arc current reached 50 amperes and the radiation spectra were photographed in a wavelength of 0.2-1.0 micrometers using the

DFS-8 diffraction spectrograph. Using this configuration, two spectro-
scopic methods of measuring the temperature of this plasma at atmospheric
pressure are compared: methods based on the measurement of the absolute
intensity of the radiation and methods based on relative intensity
measurements. Since in an absolute intensity measurement, the error can
run as high as 1,990 K at a temperature of 10,000 K for ArI at 4,510 $\overset{\circ}{A}$
under certain conditions, the method of relative intensities is to be
preferred for an argon-air gap since the error in this case can be kept to
around 300 K. Lines of ArI applicable for temperature measurement are
summarized in tabular form. Figures 2; references 9: 5 Russian,
4 Western.
[13-6225]

FOUR-POINT COHERENCE FUNCTION OF FREQUENCY-SPACED WAVES IN TURBULENT MEDIA

KAN, V., Institute of Atmospheric Physics, USSR Academy of Sciences

[Abstract] Four different variants of radiation detection at points located
at the vertices of a parallelogram are generally possible for a four-point
coherence function of two autonomous light sources with wavelengths λ_1 and

λ_2, whose radiation propagates in a locally isotropic turbulent medium.
In this connection, measurements were made of the four-point coherence func-
tion Γ_4 of two autonomous light sources with the wavelengths $\lambda_1 = 0.63\,\mu$

and $\lambda_2 = 0.44\,\mu$. Combined beams from two lasers (He-Ne and He-Cd) were
propagated through a layer of a fluid with a developed convective turbulence
within a cuvette $x = L = 35$ cm long. The measurements were conducted in the
region of random focusings of radiation intensity for values of the longi-
tudinal parameter β_0 amounting to 1.2, 1.9, and 2.7. Cross sections and

isolines of the relief of $|\Gamma_4|$ were plotted. The findings are compared with
analogous measurement findings for a single wave as well as with calcula-
tions based on formulas of the smooth perturbation method. Figures 3;
references 14: 13 Russian, 1 Western.
[15-1386]

UDC: 538.56:519.25

THE SPECTRAL DECOMPOSITION METHOD IN PROBLEMS OF THE PROPAGATION OF
OPTICAL WAVES IN TURBULENT MEDIA

AKSENOV, V. P. and MIRONOV, V. L., Institute of Atmospheric Optics,
Siberian Affiliate of the USSR Academy of Sciences

[Abstract] The phase approximation of the Huygens-Kirchhoff method (PAHKM)
used to compute fluctuations in the intensity of optical waves in randomly
inhomogeneous media, is known to be uniformly similar to the solution of
the paraxial wave equation in the Fresnel zone of a collimated optical beam
in the presence of weak and strong intensity fluctuations. In the case of
spherical waves, however, the error of PAHKM in calculating the relative
variance of intensity fluctuations becomes infinite. In this connection,
the Huygens-Kirchhoff integral, with subsequent expansion of elementary
spherical waves over plane waves, is now proposed as an approximate solu-
tion of the stochastic wave equation. That is, a mixed spectral decomposi-
tion over elementary spherical and plane waves is used, with the complex
amplitude of the plane wave being derived as the solution of an abbreviated
equation that considers only the phase fluctuations of that wave. It is
shown that the proposed approximate solution of the stochastic equation
uniformly approximates the statistical moments of the field (up to fourth
order, inclusively) under any conditions of wave propagation in turbulent
media and of diffraction on the transmitting aperture. References 12:
11 Russian, 1 Western.
[15-1386]

ON THE POSSIBILITY OF INVESTIGATING THE AUTOIONIZATION STATES OF NEGATIVE
IONS ACCORDING TO THE BROADENING AND DISPLACEMENT OF THE RYDBERG NEUTRAL
ATOM SERIES

KAULAKIS, B. P., PRESNYAKOV, L. P. and SERAPINAS, P. D., Physics Institute
imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract]   Fermi's concept of the relationship between the broadening and
displacement of the Rydberg neutral atom series in a buffer gas atmosphere,

on the one hand, and the characteristics of the elastic scattering of slow electrons on atoms, on the other, is now complemented by making allowance for scattering at quasidiscrete levels with $L > 0$. It is shown that such resonance scattering rakes a major contribution to the broadening and displacement of the Rydberg atom series, and that this completely accounts for the oscillating component of line displacement Δ and width y and makes a major contribution to their monotonic component. Comparison of the oscillation periods and amplitudes of computed and measured oscillating components of Δ and y allows an unambiguous determination of the binding energy of the quasidiscrete level, its autoionization width, orbital moment, and multiplicity. The findings are used to interpret Preznyakov's experiments with the broadening and displacement of np-levels of Cs (L. P. Preznyakov. PHYS. REV., A2, 5, 1720, 1970) and, on this basis, the presence of the autoionization ^3P level in the Cs^- ion is deduced. These findings unlock new vistas for investigating autoionization states by the spectroscopic method. Figure 1; references 8: 5 Russian, 3 Western. [160-1386]

LIVSHITS, V. YA. and KARAPETYAN, G. O.

[Abstract]   Glasses with a regular variation in their chemical composition display a gradient of physico-chemical properties, forming as a result of chemo-thermal interaction of the original homogeneous glass with the ambient medium. They are generally obtained by the ion exchange method. The development of optical focusing elements has raised the question of the properties of such gradient-type glass materials, since in a focusing element the chemical composition and all the physico-chemical characteristics of the glass vary continuously from the surface to the axis of the cylinder. On the basis of an analysis of the published literature, the characteristic g, representing the increment in property upon substitution of one silicate oxide with another and following high-temperature ion exchange, is proposed. The optical properties of gradient-type silicate glasses obtained by the ion exchange method, such as thallium (glass)-potassium (melt) and lithium (glass)-sodium (melt), are compared. A simplified procedure for evaluating the increment in the refractive index of multicomponent glasses containing several glass-forming oxides is presented. The advantages of germanate glass are pointed out, as are the prospects of tellurite-based alkali glass as the material of matrices for the development

of gradient glass, flat lenses, and other elements of gradient optics.
Figures 2; references 17: 10 Russian, 7 Western.
[177-1386]

A FUNCTIONAL ANALOG-TO-DIGITAL CONVERTER FOR A 2-BEAM ATOMIC-ABSORPTION
SPECTROPHOTOMETER

GULAKOV, I. R., KUREYCHIK, K. P. and SARZHEVSKIY, A. M.

[Abstract] An accurate measurement of the optical density, which deter-
mines the amplitude characteristics of an absorption line, is possible
only with a 2-beam atomic-absorption spectrophotometer so that nonatomic
(nonselective) absorption can be accounted for and the error it introduces
compensated. Here is shown the design of a functional analog-to-digital
converter for a pulse spectrophotometer of this kind operating with two
monochromators. This device is in principle an "amplitude - time - number
of pulses" converter with maximum precision and interference immunity. It
consists essentially of a 2-stage storing integrator, for the main beam
and the auxiliary beam, in the comparison channel and in the measurement
channel respectively. Each integrator receives its signal from the mono-
chromator through a photoelectron multiplier in the respective channel.
Each monochromator, in turn, receives two light beams: from a line-
spectrum source and from a continuous-spectrum source, the monochromator
in the measurement channel being preceded by an atomizer. The performance
of the device is analyzed on the basis of relations between flux intensity,
voltage and time. A control circuit allows the device to operate in four
different modes: one beam with one or two channels and two beams with one
or two channels. After calibration of voltages against two reference
optical densities, a measurement accuracy within 0.05-0.15% is attainable.
Figures 2; references 5: 4 Russian, 1 Western.
[175-2415]

Optoelectronics

USSR

INERTIALESS GLOW OF METALS EXPOSED TO ULTRASHORT PULSES OF COHERENT
IMFRARED RADIATION

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in
Russian Vol 30, No 3, 1979 pp 182-185 manuscript received 21 Jun 79

AGRANAT, M. B., BENDITSKIY, A. A., GANDEL'MAN, G. M., DGVYATKOV, A. G.,
KONDRATENKO, P. S., MAKSHANTSEV, B. I., RUKMAN, G. I. and STEPANOV, B. M.,
All-Union Scientific Research Institute of Optico-Physical Measurements

[Abstract] The application of ultrashort laser pulses to metals can cause
the temperature of the electron subsystem to differ from the temperature
of the ion subsystem and follow in an inertialess manner in the form of the
laser pulse. When the laser pulse is sufficiently intense, the electron
temperature T_e will be of a magnitude of from one to several thousand
degrees. In this connection it is shown for the first time that the glow
arising at the surface of a metal exposed to ultrashort pulses of coherent
infrared radiation is due to the heating of the electron gas of the metal
and that, if the magnitude of T_e is inertialess, the glow will follow in
an inertialess manner the form of the laser pulse. The range of parameters
within which inertialess T_e applies is estimated. T_e should be sufficiently
high for the electron gas of the metal to emit a detectable number of
photons. The condition of inertialessness assures the inequality $T_i \ll T_e$,
since then photon emission is entirely determined by T_e, since the number
of photon exponentially depends on T_e. These conclusions were confirmed
by subsequent experiments. The effect thus discovered can find applica-
tion in problems of inertialess conversion of ultrashort laser pulses of
10^{-10}-10^{-12} s duration in the infrared range to visible radiation at power
densities exceeding 10^8 W/cm^2. Such a conversion would make it possible
to broaden the spectral range of present-day photorecorders. References:
4 Russian.
[167-1386]

41

LOW TEMPERATURE PLASMA WITH NON-EQUILIBRIUM IONIZATION

BIBERMAN, L. M., VOROB'YEV, V. S. and YAKUBOV, I. T., Institute of High Temperatures, USSR Academy of Sciences

[Abstract] This is a review of research into low-temperature--chiefly atomic--plasma with non-equilibrium ionization, although molecular components are occasionally also considered. Plasmas of the most varied composition are considered over a range of charge concentrations of from 10^{10} to 10^{17} cm^{-3}, temperatures of from 10^3 to 10^5 K, and sizes of from fractions of a centimeter to several meters. In the description of qualitatively different non-equilibrium states allowance is made for the real energy structure of the atoms, various elementary processes, interrelationship of the energy distributions of plasma components, and effect of various equilibrium-perturbing factors. Criteria for regions of total or partial equilibrium have now been developed. The new problems to be solved are associated with the development of gas lasers and plasma chemistry. A highly important problem is that of the mutual influence of the population of the excited states of atomic and molecular components of non-equilibrium plasma. The generation of excited states by chemical reactions also is of interest. Most studies dealing with instabilities of low-temperature plasma are based on the two-temperature approximation. It would be of interest to investigate instabilities over a broader range of conditions with allowance for greater deviations from the equilibrium. The selective effect of external factors (e.g. electron beams, radiation) on discrete components and even on discrete transitions is also of great interest. Figures 21; references 103: 70 Russian, 33 Western.
[14-1386]

A STUDY OF ELECTRON-ION RECOMBINATION AND CO_2 DISSOCIATION IN THE PLASMA OF A PULSED DIFFUSE DISCHARGE TRIGGERED BY ULTRAVIOLET LIGHT

KUMLIN, A. P., LARIONOV, V. V., YUGAY, K. N. and YAROSH, A. M., Tomsk Polytechnical Institute imeni S. M. Kirov

[Abstract] Recombination and ionization processes in a pulsed plasma, as well as the dissociation of carbon dioxide in pure CO_2 and CO_2 mixed with

helium were studied. The volume of the discharge space was 37 cm^3; the anode was a metal grid and the aluminum cathode had a Rogowski profile. The interelectrode gap was preionized with the ultraviolet light of a corona discharge. A stable volumetric discharge was observed in CO_2 at a constant electrode spacing of 1.3 cm and a pressure of 160-300 mm Hg and a voltage of 19 to 25 KV. The corresponding parameters for a mixture of CO_2 and He were 600 mm Hg and 19 to 23 KV. The partial CO_2 pressure in this case varied in a range of 20-160 mm Hg. The discharge pulse width was about $3 \cdot 10^{-7}$ sec. The recombination coefficient of the CO_2 + He plasma varied with an increase in the CO_2 partial pressure from $1 \cdot 10^{-6}$ up to $1.1 \cdot 10^{-5}$ cm^3/s. This coefficient was $2.7 \cdot 10^{-5}$ cm^3/s for pure CO_2 at pressures of 220-300 mm Hg. The degree of CO_2 dissociation in this case for the mixture decreased from $4.28 \cdot 10^{-4}$ down to $2.55 \cdot 10^{-4}$, while in the second case, it was constant and equal to $1 \cdot 10^{-4}$. The dissociation coefficient tended to increase in both cases, although the electron temperature fell off. The possibility of the formation of ion and molecular complexes in this type of plasma is proposed based on a comparison of the variation in the recombination, dissociation, electron and vibrational temperature coefficients. In a pulsed diffuse plasma, the dissociation of CO_2 is realized by electron impact predominantly from excited electron-vibrational states; the recombination process of the plasma takes place with the participation of vibrationally excited molecules and complex ion and molecule aggregates. Figures 5; references 8: 7 Russian, 1 Western. [171-8225]

STABILITY OF A THIN-WALLED CYLINDRICAL SHELL UNDER EXTERNAL PRESSURES DUE
TO A "TRACKING" LOAD

HUZ', O. M., academician, Institute of Mechanics, Academy of Sciences of
the Ukrainian SSR

[Abstract] Under consideration is a thin-walled circular cylindrical shell
on hinge supports and under external pressure due to a "tracking" load, with
reinforcing hoops at the ends to ensure a zero-moment subcritical state.
A stability analysis of this shell follows the solution of the linearized
two-dimensional differential equations with appropriate boundary conditions,
according to the geometrically linear theory with application of the Kirch-
hoff-Love hypothesis of small subcritical strains. Conditions are estab-
lished under which the external pressure due to a "tracking" load becomes
equivalent to that due to a "dead" load such as a hydrostatic one. The
characteristic third-degree algebraic equation for the load parameter is
best solved numerically and the results compared with experimental data.
References 12: 11 Russian, 1 Western.
[183-2415]

SUBSONIC MOTION OF A SOLID BODY IN AN ELASTIC MEDIUM

ZVYAGIN, A. V., Department of Gas and Wave Dynamics

[Abstract] The components of the velocity vector and tensor of the
stresses arising in an elastic medium when a rigid body moves through it at
a constant velocity are found analytically. The medium is infinite and
linearly elastic, and the following boundary conditions are specified:
1) there is no separation of flow around the body; 2) there is no friction
at the surface of the body; 3) the velocity vector and stress tensor com-
ponents are zero at infinity. It is also assumed that the deformations and
the angle between a tangent to the surface of the body and the axis of
flow are small. The solution is obtained in a two dimensional formulation
for the case of subsonic flow. If the velocity of the body is less than

Rayleigh wave velocity, a paradoxial result is obtained: the conditions for the separation of the medium are observed over the entire surface of the body, which means it is impossible to realize steady-state, nonseparating motion at a velocity less than the Rayleigh wave velocity. References: 2 Russian.
[189-8225]

USSR   UDC 620.17

PLANE WAVE SCATTERING IN MEDIA HAVING A MEMORY

LOKSHIN, A. A., Department of Differential Equations

[Abstract] A fundamental solution is found to Cauchy's equation for the case of the propagation of deformations in an inhomogeneous, viscoelastic rod. It is assumed that at the boundary of two media, conditions are imposed which are equivalent to both the stresses and the accelerations of the material elements of the media being equal. The solution of the problem is predicated on the previous work of V. Ye. Rok and author ["Fundamental Solutions of Wave Equations with Time Delay" Doklady AN SSSR, Vol 238, No 6, 1978, pp 41-44], and in this case, simpler asymptotic formulas are obtained for the behavior of the plane waves. Reference: 1 Russian.
[189-8225]

ON OSCILLATIONS IN TYPE II SUPERCONDUCTORS

MINTS, R. G. and RAKHMANOV, A. L., High Temperature Institute of the USSR
Academy of Sciences, Moscow, presented by Academician A. Ye. Sheyndlin,
26 Jan 79

[Abstract] It is possible to observe electrical field and temperature
oscillations (even under steady-state ambient conditions) in thin specimens
of a rigid superconductor in the resistive state. Maxwell's equations are
used as the starting point for the derivation of critical state equations
to derive expressions for the amplitudes of the electrical field and
temperature oscillations. The following assumptions are made: the speci-
men is a plane-parallel plate of a rigid superconductor coated on both
sides with a layer of normal conductor through which a transport current
flows. Since the critical current density is a constant vector, then a
"background" electrical field should be present in the specimen in addition
to the oscillating electrical field, this "background" electrical field
arises either under nonsteady-state external conditions or under steady-
state conditions when the current exceeds the critical and a resistive
mode is established in the specimen; this latter case is considered in
detail. A further assumption is that the specimen is intensively cooled.
The conditions governing the behavior of the oscillations are defined and
a sample calculation is summarized for the case of a critical current
density of 10^5-10^6 A/cm^2, a temperature of 1 K, a thermal conductivity of
the superconductor of 10^4 erg/cm·s·K, a specific heat capacity of 10^4
erg/cm^3, and $\Delta I/I_c$ is about 1%, it is found that the frequency and
maximum amplitude of the electrical field oscillations are 10^4-10^6 s^{-1} and
10^{-3}-10^{-6} V/cm respectively. Besides the oscillations in the potential
difference in a circuit with a specified current, there are also oscilla-
tions in the current and temperature with a specified potential difference,
as well as oscillations in the magnetic flux when it penetrates into cavi-
ties in a rigid superconductor. Figures 2; references: 4 Russian.
[178-8225]

INSTABILITY OF HOMOGENEOUS MAGNETIZATION PRECESSION IN THE SUPERFLUID
A-PHASE OF He^3

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[Abstract] It is shown that in strong magnetic fields the spatially homo-
geneous magnetization precession in the A-phase of He^3 is unstable with
respect to the excitation of spin waves. This instability is due to spin-
orbital interaction. As a result, the spin system converts to a turbulent
stage characterized by marked fluctuations in magnetization density. Spin
diffusion is here an essential factor, since the A-phase exists only at
temperatures close to T_c. When combined with spin diffusion, the fluctua-
tions in magnetization density represent an effective mechanism of longi-
tudinal relaxation of magnetization. Longitudinal and transverse relaxa-
tion times in the presence of instability are estimated. References 7:
1 Russian, 6 Western.
[167-1386]

CRITICAL PHENOMENA IN SUPERCONDUCTING THIN FILMS

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[Abstract] A study was made to explore the resistive state within the
superconducting transition range in vanadium thin films. Specimens 300-
400 Å thick for this experiment had been produced by vacuum evaporation of
vanadium with a sharply focused electron beam. The fine-grain structure
of the films was the same as that of bulk vanadium, but without grain
orientation. The resistive transitions were measured while the temperature
and the current as well as the magnetic field intensity were varied below
their respective critical levels. These measurements were made in a cryo-
stat with a superconducting solenoid inside, with the temperature at each
test point from 4.2 to 2 K maintained constant within 0.001 K. An evalua-
tion of the data by the method of least squares has revealed that the

excess electrical conductivity in this range depends exponentially on $1-T/T_c$ and on $1-I/I_c$ as well as on $1-H/H_c$ whether the magnetic field is perpendicular ($H \perp$) or parallel ($H \parallel$) to the plane of the film, these relations being subject to dimensional similarity laws. This new evidence is interpreted through the fluctuation theory of phase transitions of the second kind. The critical region with strong fluctuations can thus be represented on a T,H,I-diagram and evidently the resistivity of vanadium films is determined by changes in the order parameter, due to its fluctuations inside this critical region. The trend of the field dependence of the excess conductivity changes with temperature in a parallel magnetic field but not in a perpendicular magnetic field. The authors thank V. V. SHMIDT, I. O. KULIK, V. P. GA'AYKO and R. I. SHEKHTER for the useful discussions, also T. A. KOVALENKO for the electron-microscope photographs of specimens and YE. P. LEVCHENKO for the help in computer processing of the experimental data. Figures 7; references 30: 15 Russian, 15 Western.
[176-2415]

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[Abstract] For a more complete analysis of the spin dynamics in superfluid He^3, the phenomenological equations describing the magnetization relaxation in strong magnetic fields are considered, strong fields being those where the spin-orbital interaction energy is much lower than the Zeeman energy. The equations of motion for the hydrodynamic range is derived from the appropriate Hamiltonian, assuming zero dissipation. The motion is then split into components of very different frequencies and the equations averaged with respect to the fast variables, according to the Van der Pol approximation. For a system initially at equilibrium, this procedure is applied to two extreme phases in He^3: A-phase with the vector order parameter perpendicular to the external magnetic field and B-phase with axis of anisotropy of this parameter parallel to the external magnetic field. The results of calculations confirm available experimental data on the nature of magnetic relaxation and the trend of its change in time due to changes in ambient conditions, temperature and magnetic field, with an interpretation possible in terms of a single phenomenological parameter. Figures 4; references 11: 4 Russian, 7 Western.
[176-2415]

KINETIC PROPERTIES OF SUPERCONDUCTORS WITH STRUCTURAL TRANSFORMATION

KOPAYEV, YU. V., MENYAYLENKO, V. V. and MOLOTKOV, S. N., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract]   Compounds behaving as superconductors at the highest tempera-
ture are known to have a narrow forbidden band and to undergo structural
transformation near the superconducting transition temperature. Here the
kinetic properties of such superconductors with a β-W structure are evalu-
ated, namely their absorption of high-frequency ultrasound and rate of
nuclear spin-lattice relaxation. The ultrasound absorption is calculated
for a superconductor with partial dielectrization of electrons, assuming
absorption of sound quanta by free quasi-particle excitations only, and its
temperature dependence is found to have an anomaly in the form of a peak
at the superconducting transition point due to dielectric correlation of
conduction electrons with a possibility of cubic phase to tetragonal phase
transformation. The relaxation of nuclear spin is calculated from the
Hamiltonian of hyperfine electron-(nuclear)spin interaction. In the case
of highly doped superconducting semiconductors with a wide forbidden band
and a structural transformation temperature much higher than the super-
conducting transition temperature, sometimes even higher than the melting
point and thus unobservable, first the transition from semimetallic phase
to dielectric phase is considered and thus the intraband Cooper pairing
as well as the stability of the system with respect to it. This analysis
is extended to a 2-band superconductor, such as a semimetal, with essen-
tially noncongruent Fermi surfaces of electrons and holes, insignificant
dielectric correlations and no structural transformation at all. Figures
4; references 18: 7 Russian, 11 Western.
[176-2415]

QUANTUM EFFECTS IN COSMOLOGY

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[Abstract] Quantum effects of the vacuum, resulting in the formation of
particle masses, are a major factor in the various models of unified
theories of physical interactions, particularly in the Weinberg-Salam type
models with spontaneous violation of gage symmetry, which combine weak and
electromagnetic interactions, as well as in models that also include strong
interactions. Furthermore, considering that in theories of gravity the
nonzero vacuum is, like matter, a source of the gravitational field, the
problem must be examined from the self-consistent standpoint, with allow-
ance for equations of the gravitational field as well, in the spirit of
Einstein's theory of gravity. Accordingly two types of spontaneous dis-
turbance of symmetry are examined within the framework of the self-
consistent scheme: 1) spontaneous violation of conformal symmetry and 2)
spontaneous violation of gage symmetry. Analysis of 1) points to the
presence of the Einsteinian term $R/2k$ in the Weinberg-Salam type Lagrangian,
which signifies that Einsteinian gravitation can be interpreted as a
classical manifestation of quantum properties of the vacuum. Analysis of
2) shows that quantum vacuum effects, that is, in this case, the spontaneous
violation of gage symmetry, result in preventing the singular state in
cosmology. The following scenario for the Universe may be deduced: 1)
spontaneous violation of conformal symmetry of the vacuum field and the
appearance of Einsteinian gravity as a classical manifestation of that
effect; 2) spontaneous violation of gage symmetry and the commencement of
evolution from nonsingular state as a quantum effect of the vacuum; 3)
appearance of the entire mass as an effect of generation in an evolving
gravitational field, which is in agreement with the Dirac hypothesis of
large numbers. References 13: 11 Russian, 2 Western.
[180-1386]

USSR

L-A PAIR OF A COUPLED SYSTEM OF EQUATIONS OF GRAVITATIONAL AND
ELECTROMAGNETIC FIELDS

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[Abstract]   L-A equations corresponding to equations of gravity in a vacuum are known to exist for the case in which the metric is solely a function of the time t and a single spatial variable z (V. A. Belinskiy and V. Ye. Zakharov, ZHETF, Vol 75, 1953, 1978). It is also known that this procedure applies equally to a space filled with an ideal fluid with the equation of state $\mathcal{E} = p$ (V. A. Belinskiy, ZHETF, Vol 77, No 10, 1979). Now yet another case of integrable equations of the general theory of relativity is pointed out. Namely, it is shown that the coupled Einstein-Maxwell system of equations admits the existence of the L-A pair if: 1) the metric and the electromagnetic potential are functions of only two variables; 2) charges and currents are absent; and 3) the electromagnetic field invariant $F_{ik}F^{ik'}$ is zero. Corresponding necessary and sufficient L-A equations are constructed. References: 2 Russian.
[160-1386]

SOLUTION OF THE PROBLEM OF LINEAR FILTRATION IN THE PRESENCE OF NONWHITE
NOISE IN OBSERVATIONS

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[Abstract]   A method of solving the problem of linear filtration is proposed where, within the scope of regular analysis involving Hilbert spaces, the equation of state refers to a negative space. The linear filter operating on sample functions of the observed process is described by differential equations in the regular rather than stochastic sense. The noise in the observations is assumed to be nonwhite or degenerate white, i.e., to be a random process with not all elements of the covariant matrix containing Dirac delta functions. With the aid of an appropriate definition, the problem is formulated for the case where some components of the state vector are observed exactly without noise and all others with a white noise. Solving this problem is equivalent to solving a Wiener-Hopf integral equation of the second kind, the algorithm of the solution involving regularization of this equation. Five theorems are proved regarding the equation, its solution and the sequence of estimates obtained as a result. Under certain conditions this sequence satisfies the Riccati differential equation. References 11: 6 Russian, 5 Western.
[174-2415]

SOLUTION OF THE HEAT CONDUCTION PROBLEM IN THE CASE OF NONAXISYMMETRICALLY
HEATED SOLIDS OF REVOLUTION

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[Abstract]   A solid of revolution with an arbitrary cross section is non-
axisymmetrically heated. The problem of transient heat conduction through
such a body is considered, assuming convective heat transfer from its sur-
face to the ambient medium. The system of variational equations describing
this problem is solved by the finite element method, in this case sectoral
elements with six vertices each into which the body volume has been sub-
divided, and finite differences into which the derivatives of nodal temper-
atures of each element with respect to time have been converted. Thus
minimization of the thermal flux functional is reduced to a system of
algebraic equations solvable by an implicit scheme with iterations. The
article was presented by Academician (Academy of Sciences of the Ukrainian
SSR) O. M. HUZ'. References 5: 4 Russian, 1 Western.
[183-2415]

LOW TEMPERATURE CALORIMETRY OF BIOLOGICAL MACROMOLECULES

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[Abstract] This review represents an attempt to collate and assess various
experimental data on biopolymer physics as well as on conformational analy-
sis and the thermal properties of macromolecules, with the object of
uncovering new characteristic structural properties of biopolymer chains.
At the same time, this review represents the first attempt of its kind to
collate and classify in a single study the experimental data on the heat
capacities of amino acids, peptides, polypeptides, proteins, and nucleic
acids, and to compare them with the existing theories of the heat capacity
of strongly anisotropic structures at low temperatures. The features

reviewed include the specific heats and thermodynamic parameters of: amino acid residues at 1.5-350 K; polypeptides at 1.5-300 K; and globular proteins at 10-350 K. In addition, the thermodynamic properties of fibrillary protein-collagen is helical and glomerular states at 4-400 K are reviewed, as are the heat capacity of DNA at low temperatures and the anomalies of the low-temperature heat capacity of melanine in tumoral melaonsoma. It is shown that achievements of the theory of the heat capacity of strongly anisotropic solids can be utilized to develop the theory of the heat capacity of biopolymers in solid state at low temperatures. Another conclusion is that the method of preparing specimens for calorimetry is a decisive factor: special attention should be devoted to the water/biopolymer molar ratio. The discovery of low-temperature phase transitions in bio-macromolecules opens new prospects for their research. Further, research into the low-temperature heat capacity of liquid-crystal structures of biological origin is highly important and promising. But "molecular cryobiophysics" cannot be based on thermal measurement techniques alone: other modern techniques (radiospectroscopy, neutrondiffraction, nuclear spectroscopy, electrical methods) should also be utilized for this purpose so as to yield fundamental data that could be utilized to construct a physical theory accounting for the functional properties of protein and nucleic-acid macromolecules. In the USSR research into the calorimetry of biological specimens had been initiated by E. L. Andronikashvili and his disciples as far back as in 1956. Figures 41; references 120: 57 Russian, 63 Western.
[14-1386]

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